CANADIAN ENERGY RESEARCH INSTITUTE

Study No. 168
February 2018

CANADIAN ENERGY RESEARCH INSTITUTE

# A COMPREHENSIVE GUIDE TO ELECTRICITY GENERATION OPTIONS IN CANADA

# Executive Summary

The purpose of this research was to document the variation in electricity generation costs by province across Canada. Governments and stakeholders are in discussion regarding how to decarbonize our electricity system and use it for the substitution of some energy services from fossil fuels such as home heating and transportation.

The electricity grid across Canada is fragmented by province and as such each faces different costs. While there are other elements associated with the management of our electricity systems such as smart grids and demand-side management, generation is still the key part of the system to provide services we have come to depend on in modern society.

CERI has undertaken an extensive and comprehensive look at the options facing provincial governments. These generation options represent part of the solution to a complex challenge of just in time delivery of electricity to our businesses and homes. We have developed detailed datasets and analytical tools that not only compare and contrast the choices within a province, but also demonstrate that one size does not fit all.

Our assessment is based on the economic cost of adding new generation, either for the replacement of generators retiring or to help meet growing demand as more services move from other energy sources to electricity. The results are summarized in Table E.1. They show the lowest cost generation options by province for firm and intermittent power. Also, in comparison to a natural gas combined cycle plant (NGCC), the cost of reducing carbon emissions is negative in all cases.

**Table E.1: Provincial Results**

| Province | Least Cost Intermittent Power (cents/kWh) | Least Cost Firm Power (cents/kWh) | Cost of Reduced $CO_2$ Emissions of the Firm Power Option ($/tonne) |
|---|---|---|---|
| NL | Wind – 6.1 | Wind + Hydro – 7.6 | N/A |
| PE | Wind – 6.3 | Wind + NGCC – 7.2 | -57 |
| NS | Wind – 6.4 | Wind + NGCC – 7.8 | -110 |
| NB | Wind – 6.8 | Wind + NGCC – 7.4 | -44 |
| QC | Wind – 6.8 | Biomass – 5.2 | -88 |
| ON | Wind – 6.6 | Biomass – 5.1 | -93 |
| MB | Wind – 6.4 | Biomass – 5.1 | -17 |
| SK | Wind – 5.6 | Biomass – 5.0 | -17 |
| AB | Wind – 5.7 | Biomass – 4.9 | -20 |
| BC | Wind – 7.5 | Biomass – 4.3 | -40 |

The provincial results indicate that wind, NGCC and biomass are options to consider across the country when evaluating the least cost options to add electricity generation to provincial grids. Costs range from a low of 4.3 cents/kWh in British Columbia (BC) for firm biomass generation to a high of 7.8 cents /kWh in Nova Scotia (NS) for a hybrid wind and NGCC option. In all cases, the selection of these options leads to a decrease in emissions at a lower cost than the base case option of NGCC. A caveat with respect to biomass is the amount of resource available. While it is the cheapest firm power option in several provinces, the amount of electricity that can be generated is limited, in comparison to other generation alternatives.

If we consider the more expensive options for electricity generation, they include small modular reactors, coal, solar and geothermal. These options may have other characteristics that would promote their use, for example, in off-grid locations. However, from a cost perspective in terms of both retail prices and reduction in carbon dioxide emissions they are more expensive.

We have put our best efforts to provide information that enables comparison of generation technologies on a common ground. For example, for intermittent generation sources, we estimate the cost of managing their variability in several different ways. These include the assessment of levelized cost of electricity (LCOE) and emissions of firming intermittent sources with natural gas-fired generation and compressed air energy storage systems.

CERI has not included elements such as smart grid investments, demand response or energy efficiency activities in this analysis. What our research does provide is an economic benchmark from which to judge the cost effectiveness of those programs. If the programs can reduce

electricity consumption at a cost less than the generation option, then they would be considered economic. It should also be noted that the full cost of generation as an avoided cost benchmark can only be used if there is permanent avoidance of new generation. If these demand management programs only delay the generation investment, it is the time value of the delay which provides the economic benchmark. Generally speaking, demand management programs that are more expensive than the generation option may provide other benefits, but would not be justified on a simple cost/benefit basis.